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Joint ICTP-IAEA School of Nuclear Energy Management

8 - 26 August 2011

Nuclear Power: Present, Past and Future

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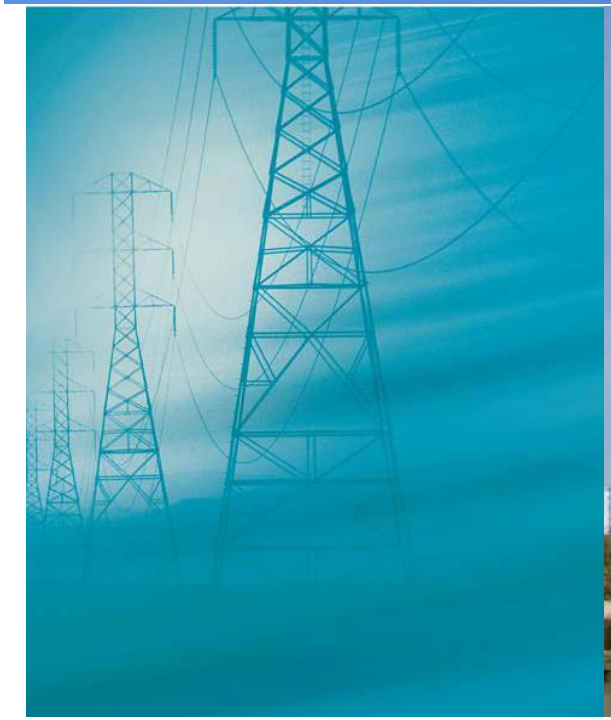
Austria

Strada Costiera 11, 34151 Trieste, Italy - Tel.+39 040 2240 111; Fax +39 040 224 163 - sci_info@ictp.it



Nuclear Power: Present, Past and Future

Alexander V. Bychkov
Deputy Director General

The Role of Nuclear Power in the Future Energy Mix

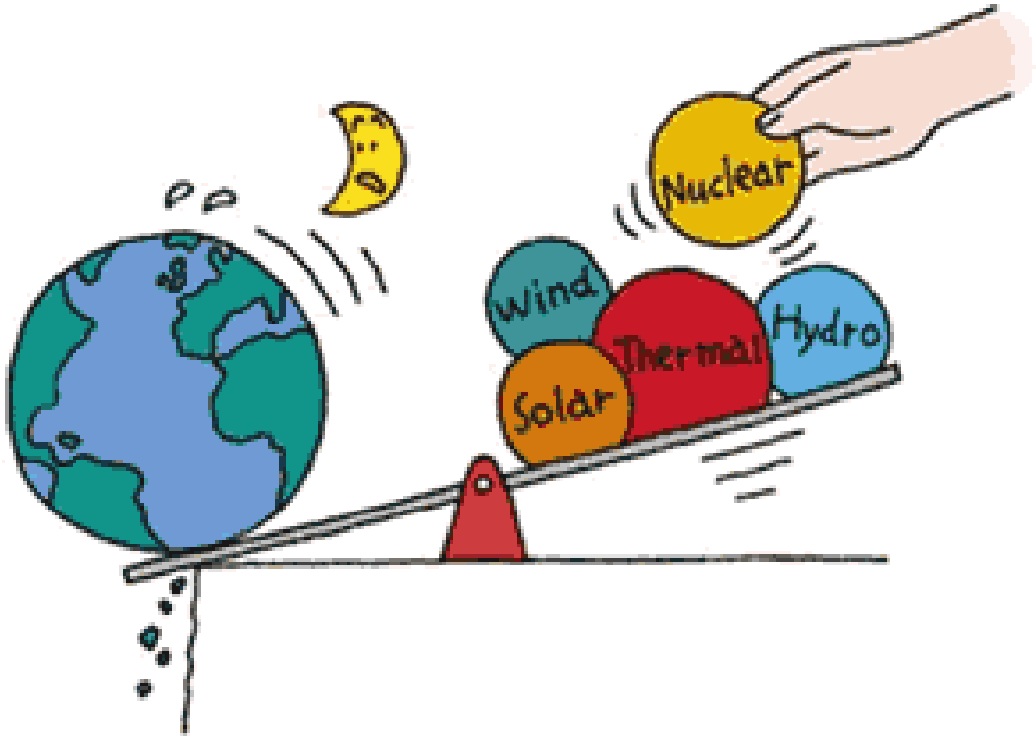
- Continued growth in global energy demand
- Energy security
- Price volatility
- Environment protection and climate change

Nuclear power:

Improved operations, good economics and safety record starting in the early 1990s

In spite of economic crisis:

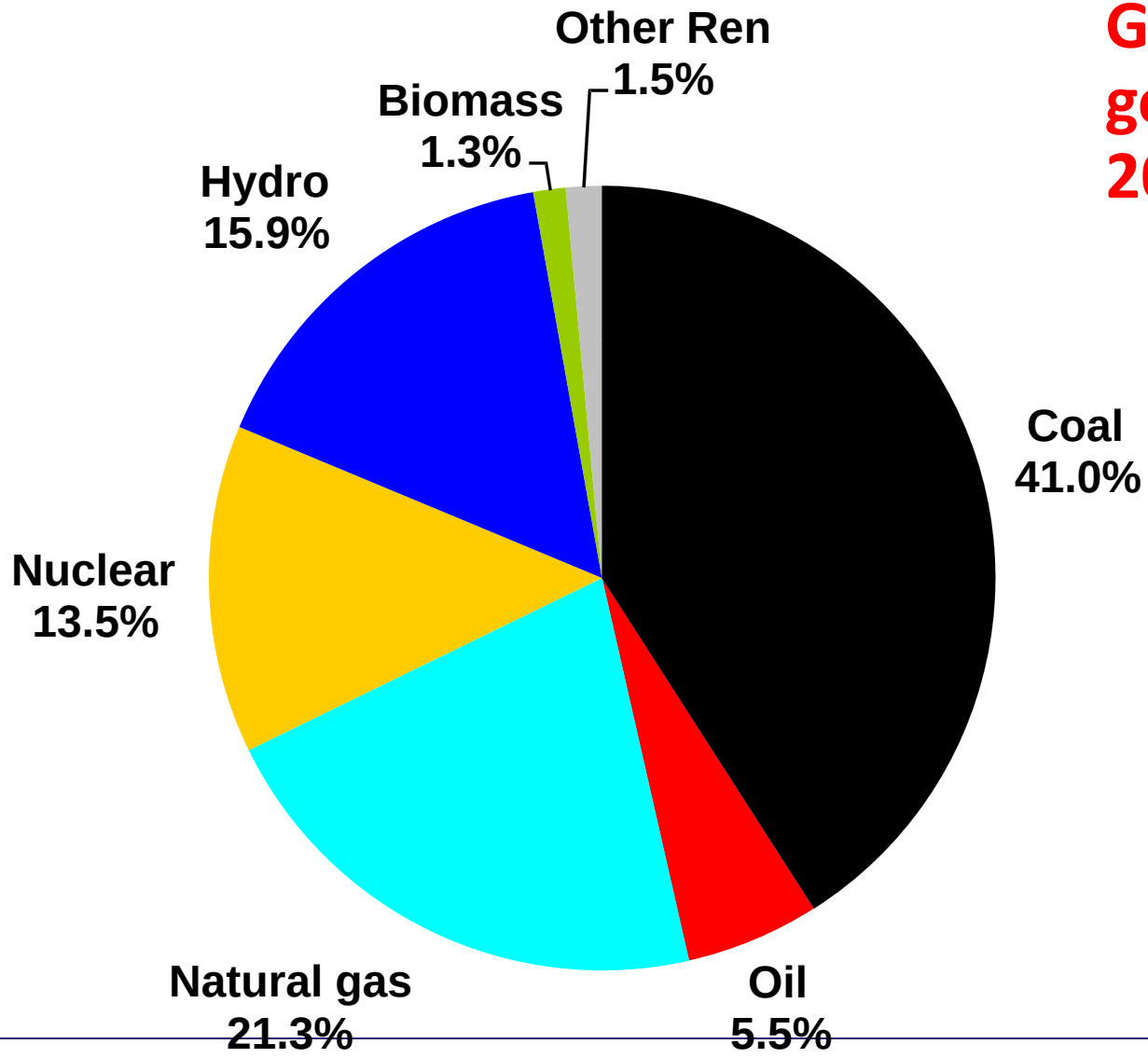
- **Prospects better than ever since the mid 1990s**



Does Fukushima-I not effect on Nuclear Growth?

Fukushima-I does not effect on Nuclear Growth!

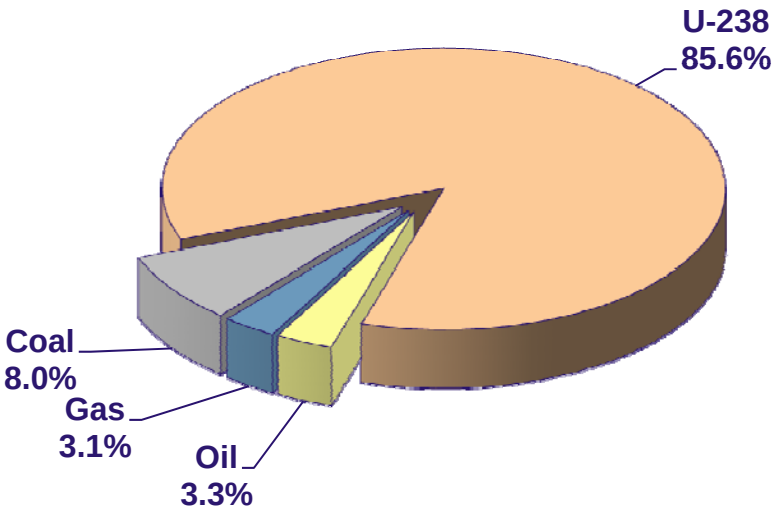
Structure of global electricity supply

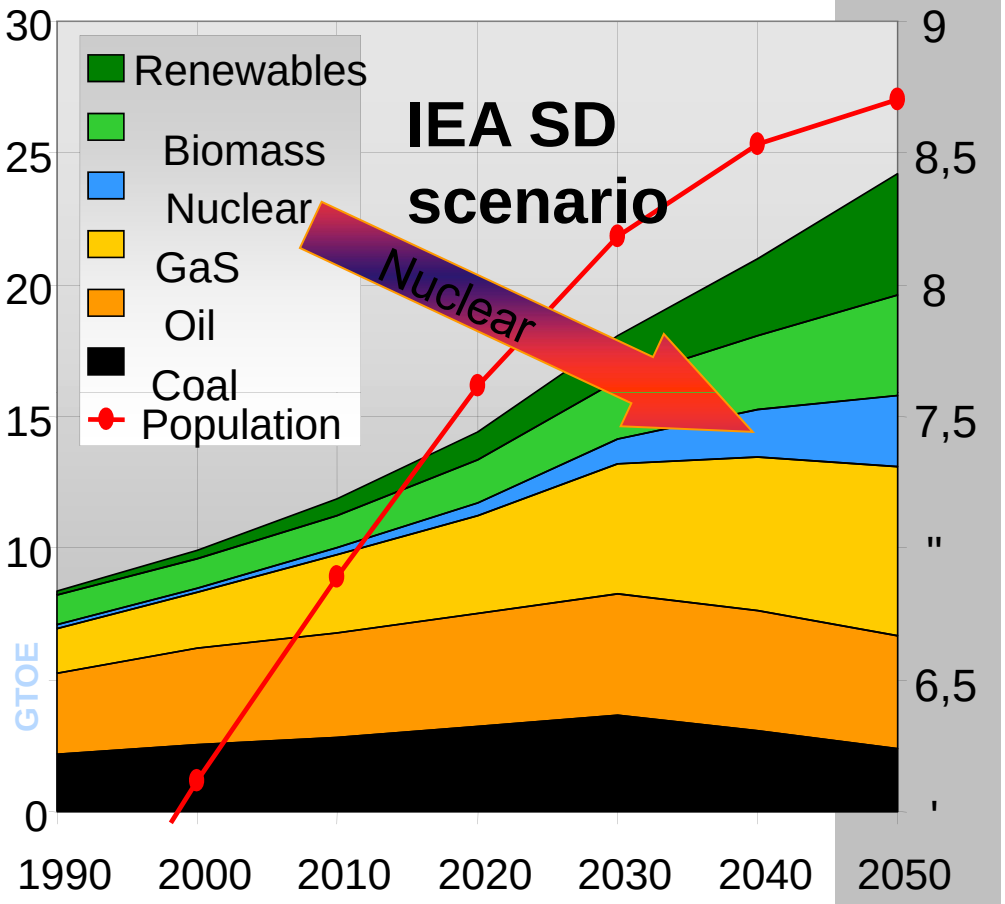


Global electricity generation in 2008: 20 180 TWh

Nuclear power & Sustainable development

Uranium Resources for Fast Reactor Closed fuel cycle





Th resources for Th - U-233 fuel Cycle

Source IEA: Energy to 2050 - Scenarios of for a Of sustainable Of future

Expected Fusion Energy

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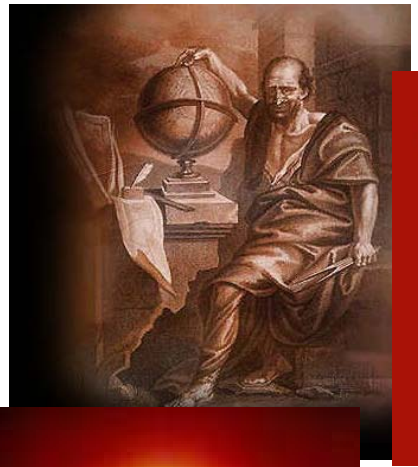
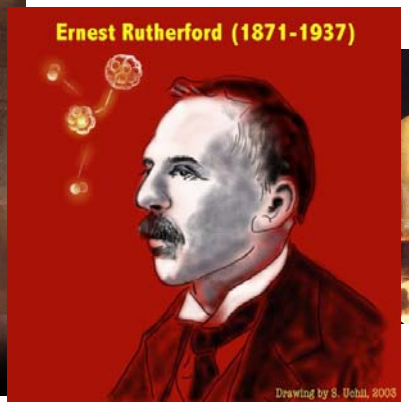
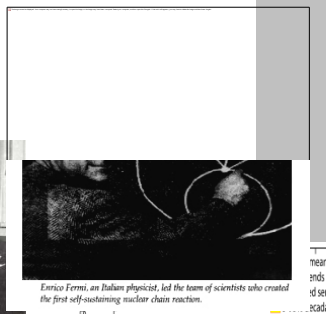
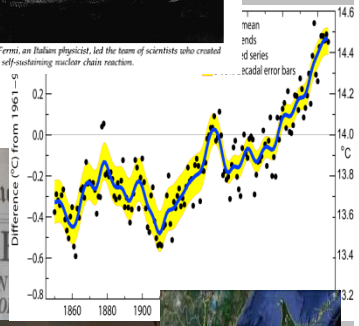
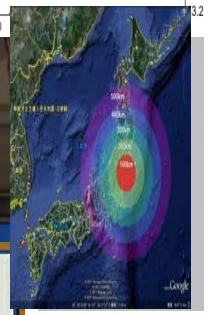
History of Nuclear Development

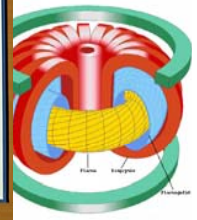




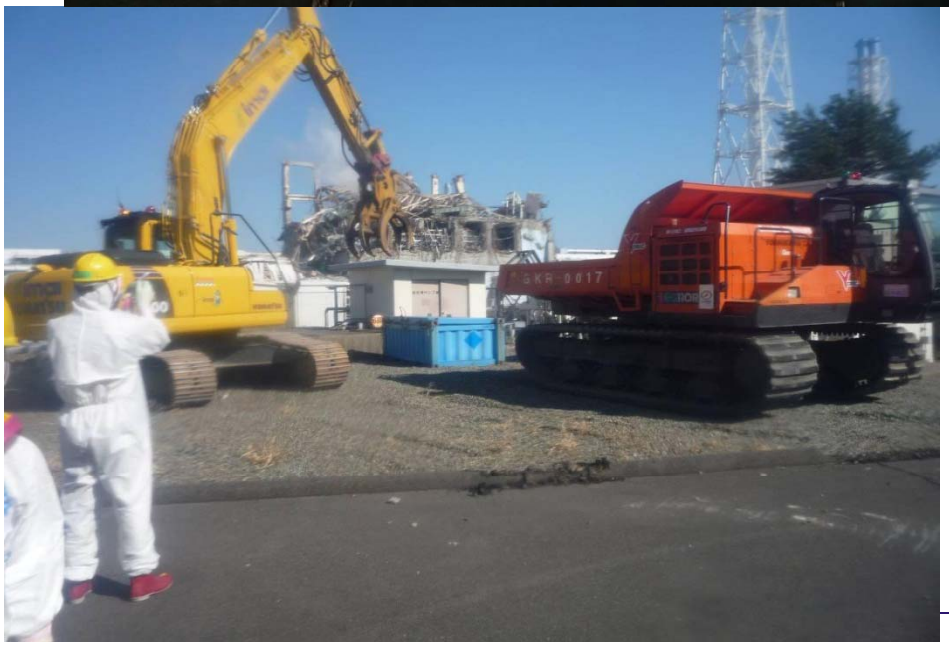


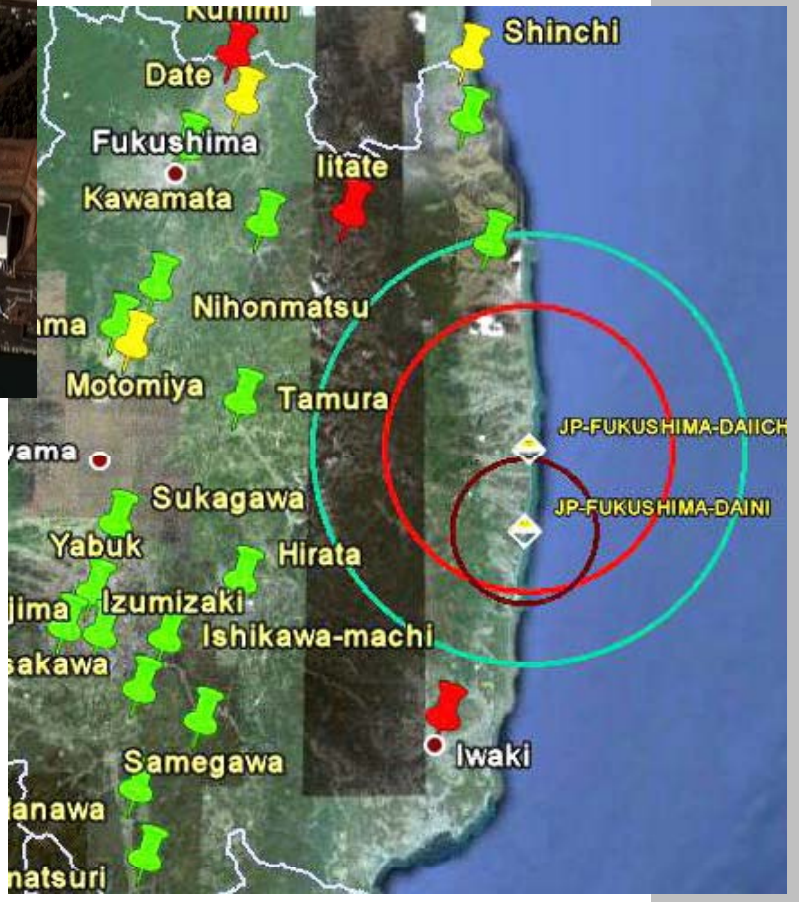




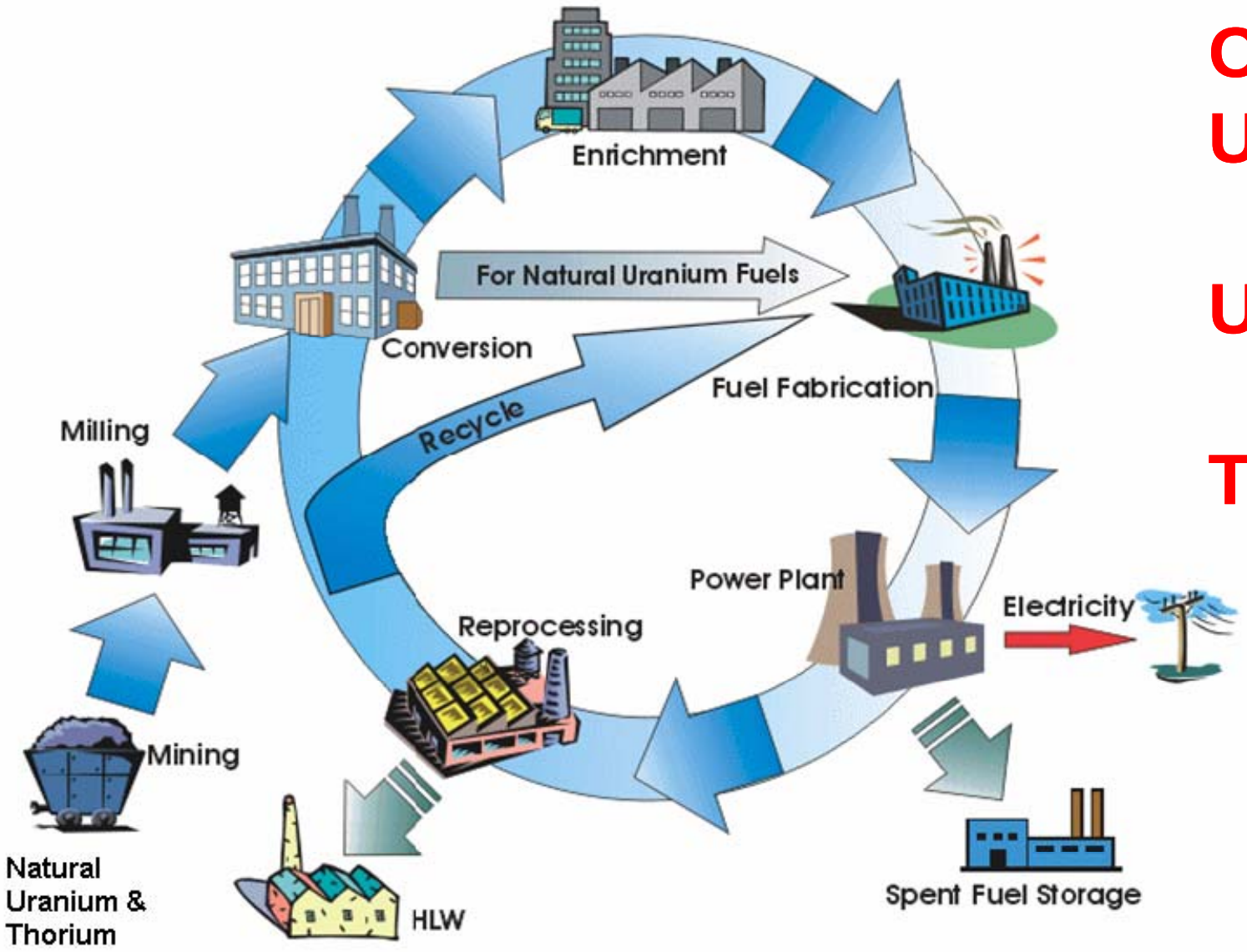


FUKUSHIMA…




Shinchi
Date
Fukushima
Iitate
Kawamata
Nihonmatsu
Motomiya
Tamura
JP-FUKUSHIMA-DAIICH
JP-FUKUSHIMA-DAINI
Sukagawa
Yabuk
Hirata
Izumizaki
Ishikawa-machi
Iwaki
Samegawa

Nuclear Fuel Cycle



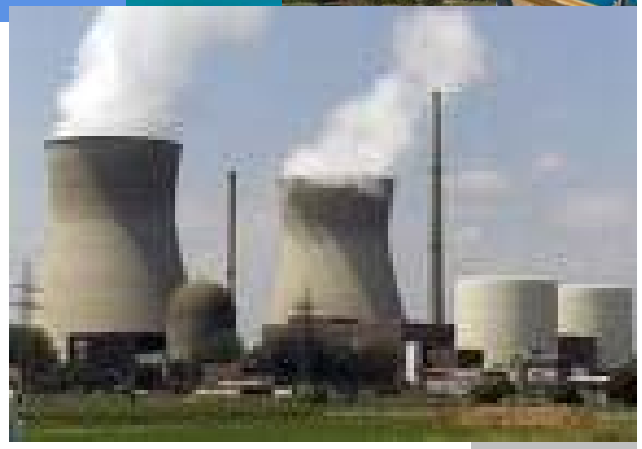
Options:

U-235

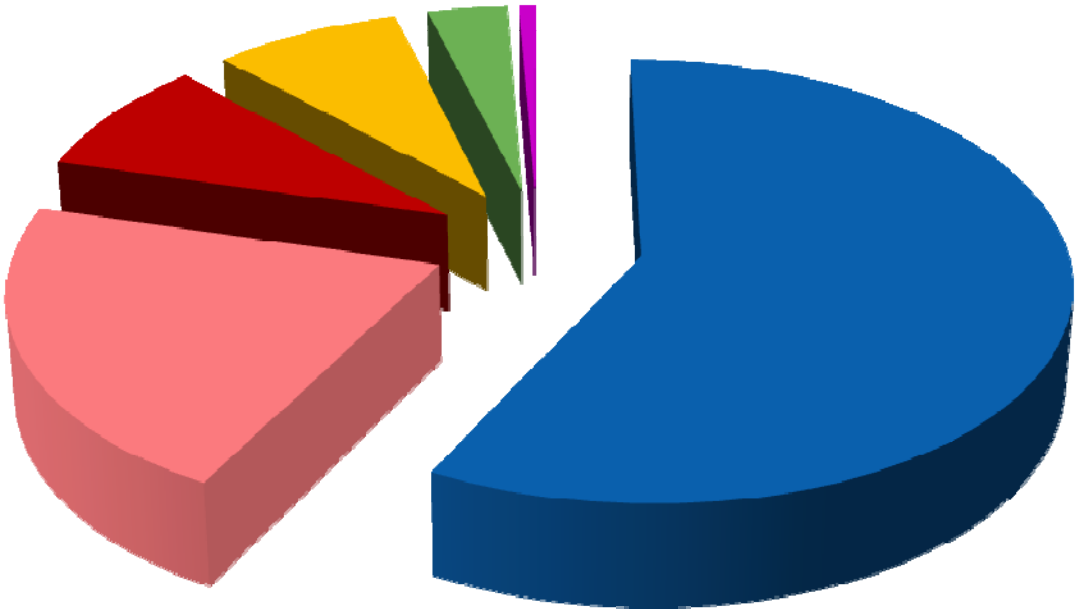
U-238 – Pu

Th – U-233

Nuclear Reactor – key element of Nuclear Fuel Cycle



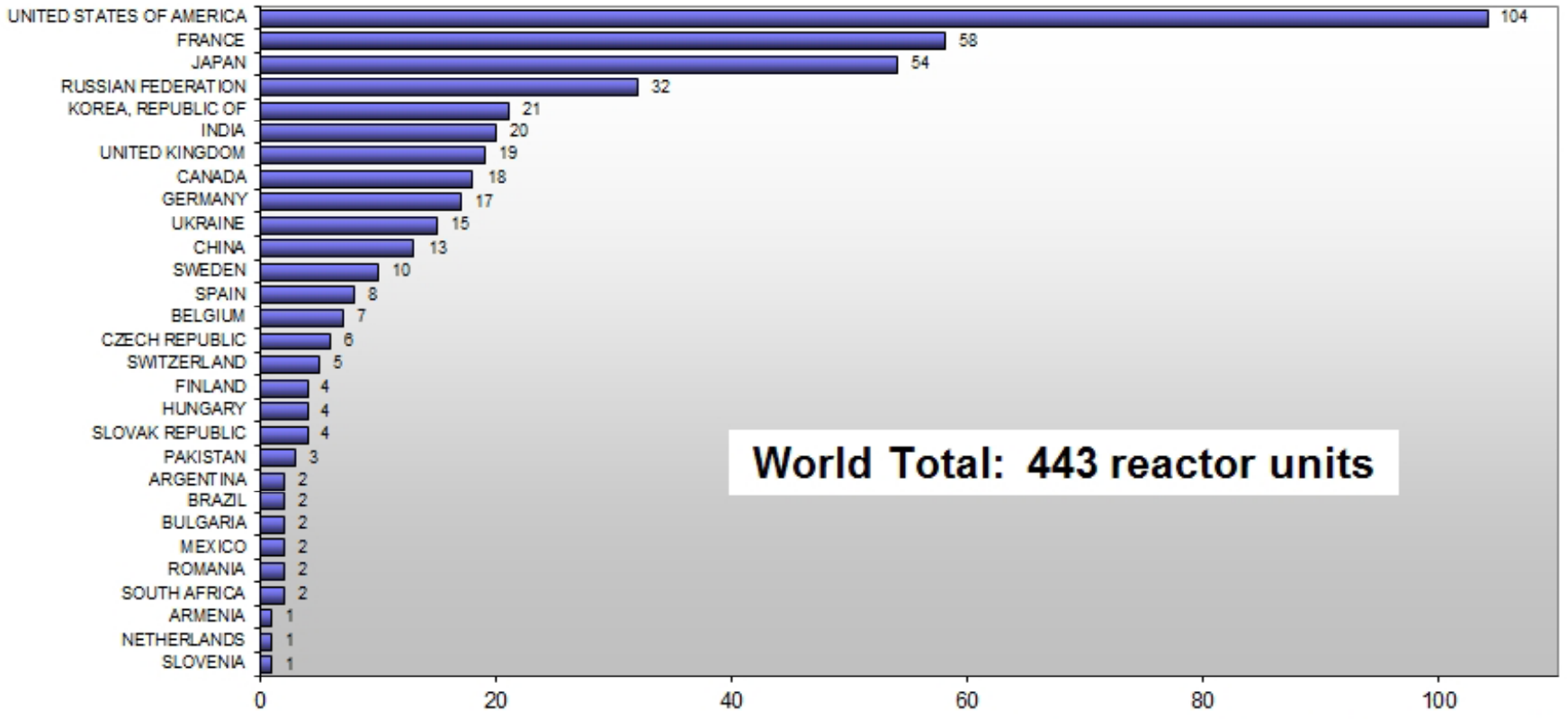
Reactor Types Used in the World



- Pressurized Water Reactors (58%)
- Boiling Water Reactors (22%)
- Heavy Water Moderated Reactors (8%)
- Gas Cooled Reactors (8%)
- Graphite Moderated Reactors (3%)
- Other Reactors (1%)

Distribution of NPPs

Number of Reactors in Operation Worldwide



Note:Long-term shutdown units (5) are not counted

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2010 – From rising expectations to renaissance?

- 442 reactors in operation, up from 437 at the end of 2009
- 374 GWe total installed capacity, up from 371 GWe at the end of 2009
- 5 new reactors connected to the grid, up from 2 in 2009 and 0 in 2008
- 2 reactor shutdowns in 2010, and 2 in 2009
- 12 new construction starts; compared to 12 in 2009 and 10 in 2008
- 24 of 29 operating countries are considering expansion
- 2 “newcomers” ordered their first NPPs

Core of the future

Number of reactors Under construction

Reactor vendor

Type of reactor:

- Pressurised water reactor
- Advanced Pressurised water reactor
- Pressurised heavy water reactor
- Pressurised water reactor/ water energetic reactor
- Advanced boiling water reactor
- Fast breeder reactor

Russia

JSC

Rosenergoatom

10

Japan

2

Hitachi

Westinghouse

Areva

China

26

China National Nuclear Corp

Finland

1

Areva/ Siemens

India

7

Russian Ministry Of Atomic Energy

Indian Department of Atomic Energy

France

1

Areva

Kepco

A

5

Doosan Heavy Industry and Construction Co

South Korea

Source : Financial Times

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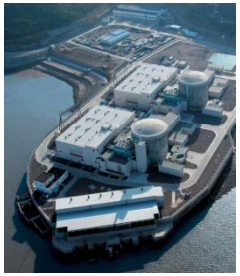
Classification of Nuclear Reactors

Generation I

Early phase: Shippingport, Dresden, Fermi I, Magnox

Generation II

Most operating reactors: LWR (PWR, BWR), CANDU, VVER, RBMK, AGR

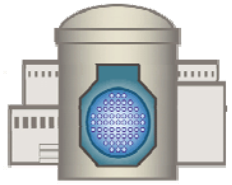


Generation III

Improved designs: ABWR, AP600, System 80+, EPR, EC6

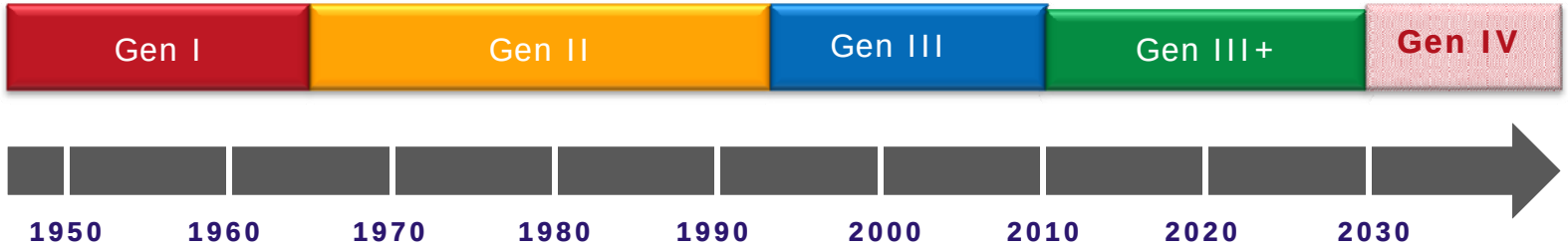
Generation III+

Evolutionary design with improved economics: AP1000, EPR1000, ACR1000

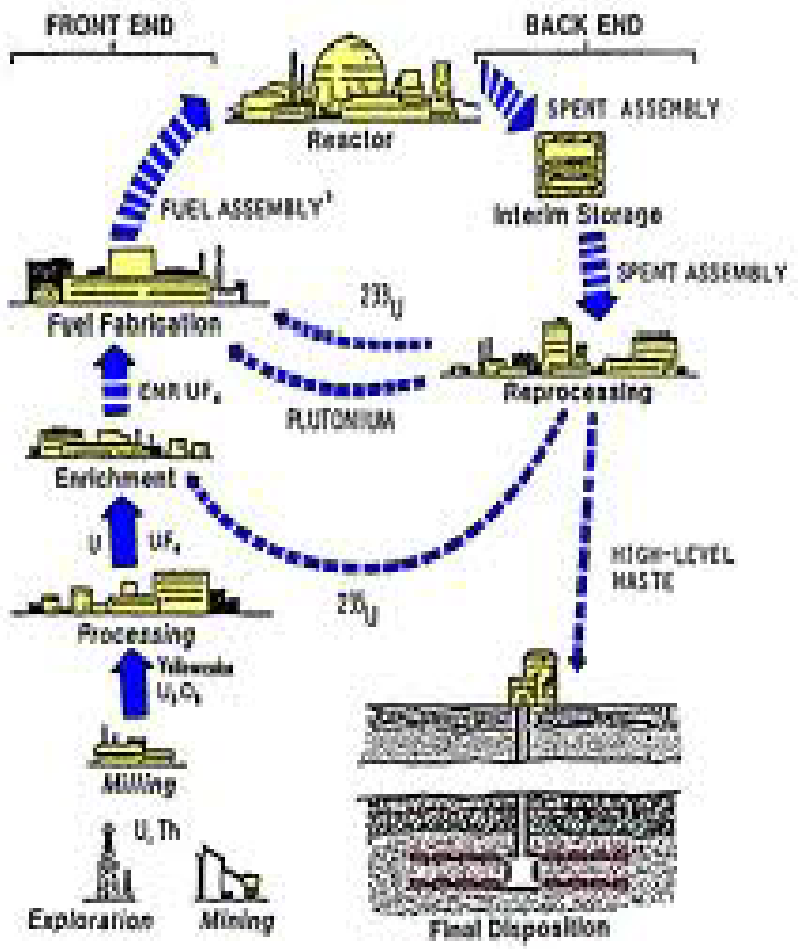


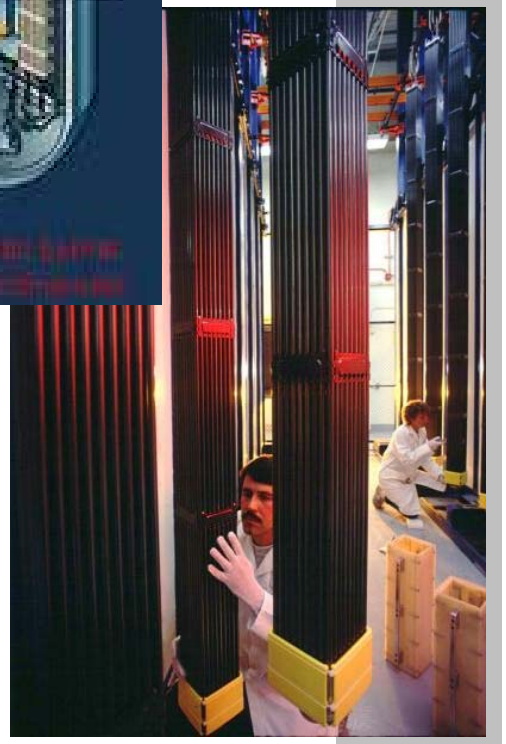
Generation IV

Highly economic, enhanced safety, minimize waste, proliferation resistant

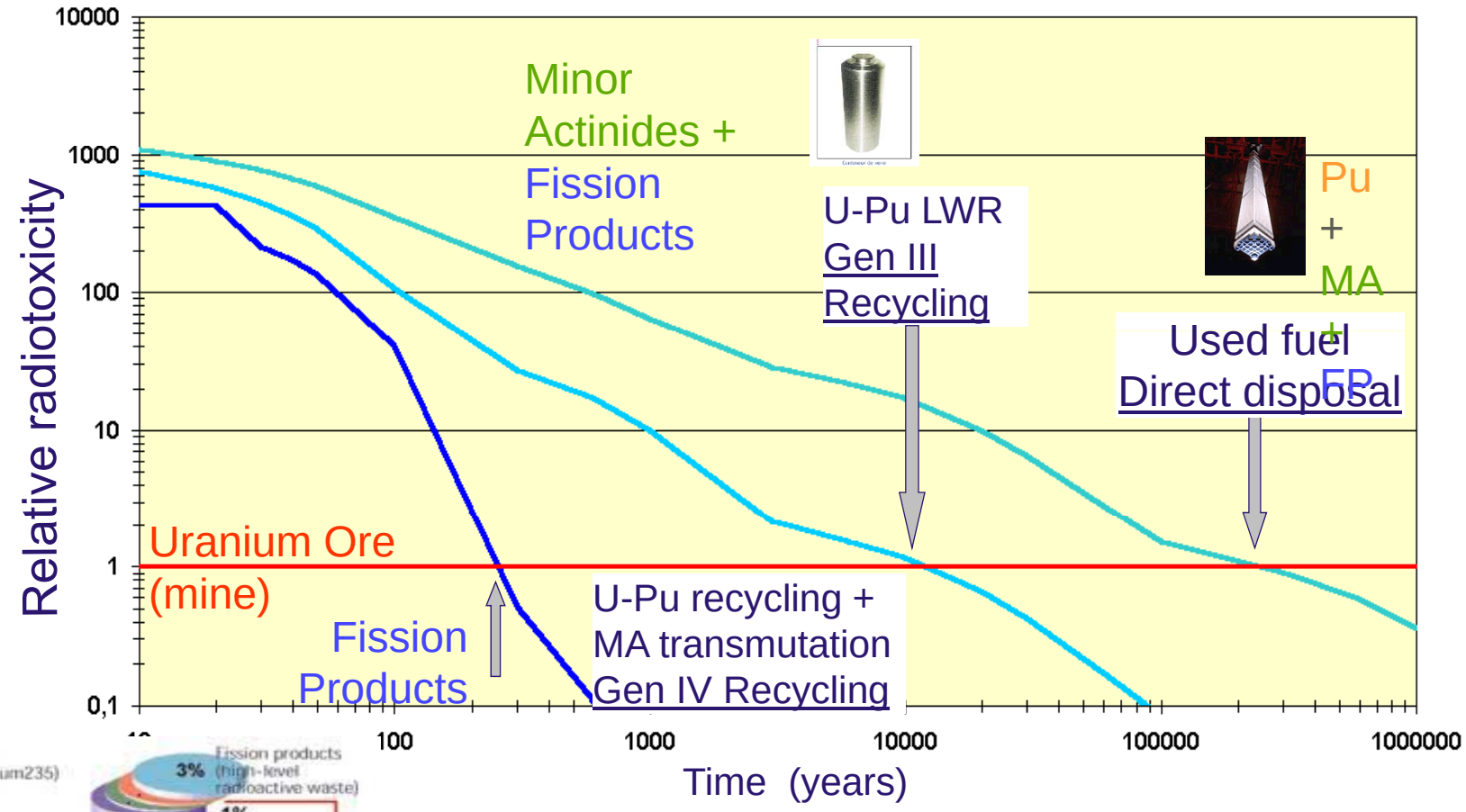


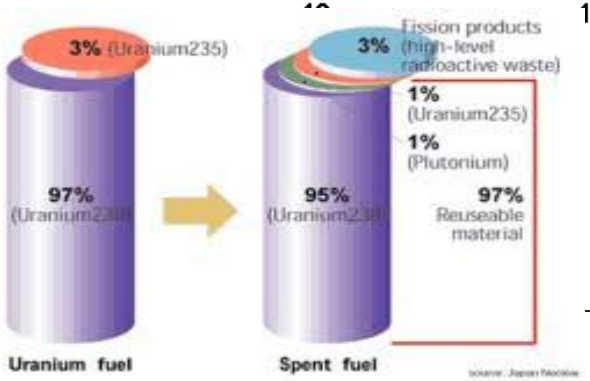
Front End of Fuel cycle





Back End of Fuel Cycle





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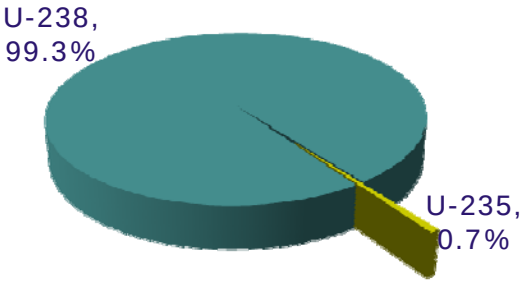
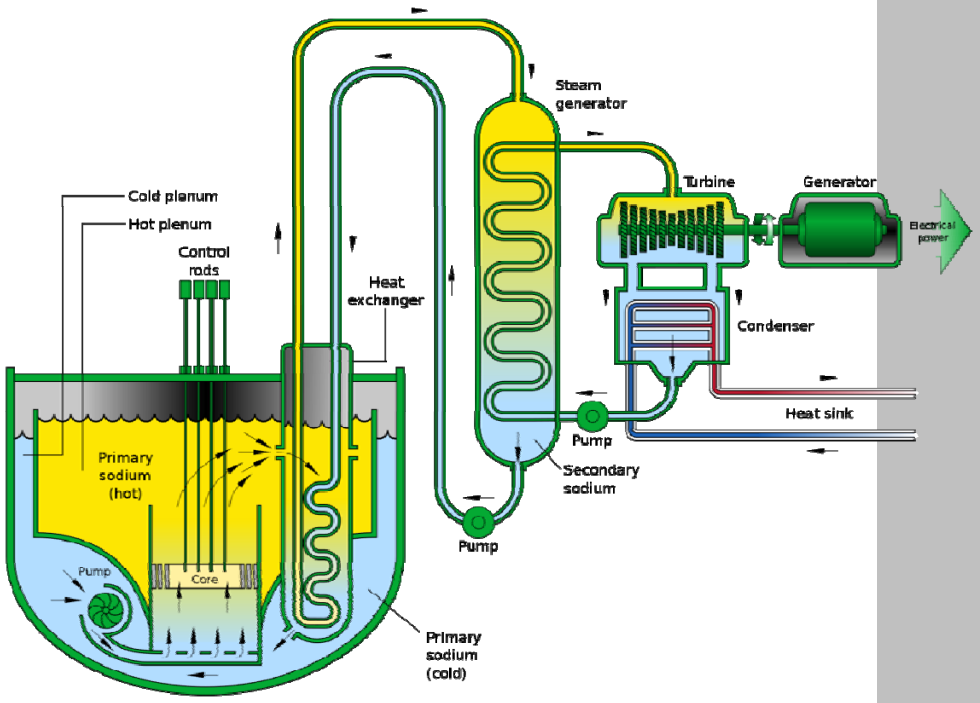
Fast Reactor Fuel Cycles

Fast neutron spectrum reactors can:

- Produce more fissile material (Pu) than they consume (breeding)
- Effectively fission (transmute) long-lived minor actinides.





Waste Management

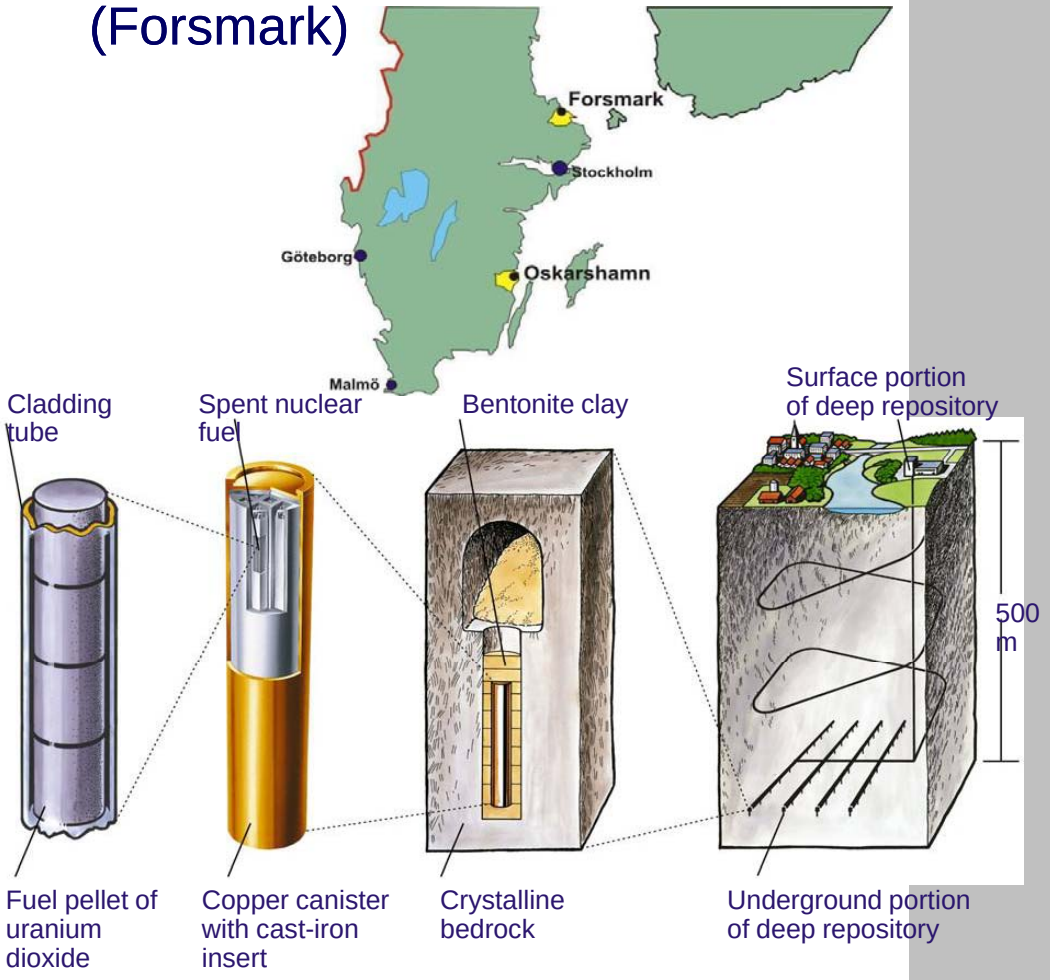
Waste management is not an "option"

Open Cycle requires disposal of spent fuel

Closed cycle requires disposal of HLW

All countries embarking on a nuclear energy programme must take responsibility for the wastes generated.

Sweden Program:
Repository Construction: 2015-2025
(Forsmark)



Nuclear Safety

International Nuclear Safety System

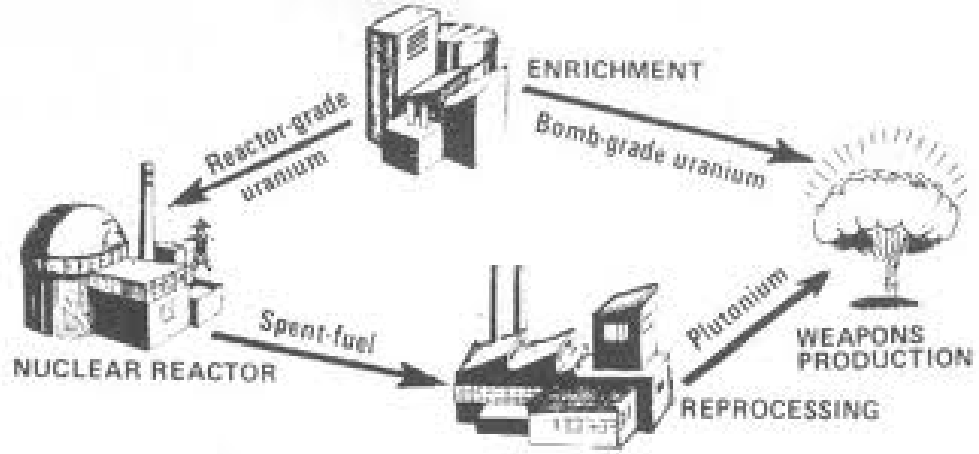
- For Nuclear Reactors and other Installations (incl. Fuel Cycle)
- For transportation and application
- Support of Regulatory Bodies

Philosophy of Safety:

- Technologies with inherent safety
- Experience and knowledge
- Quality control
- Operators responsibilities
- **Regulator independence**

Non-Proliferation Aspects

Treaty on Non-Proliferation of Nuclear Weapons (NPT)

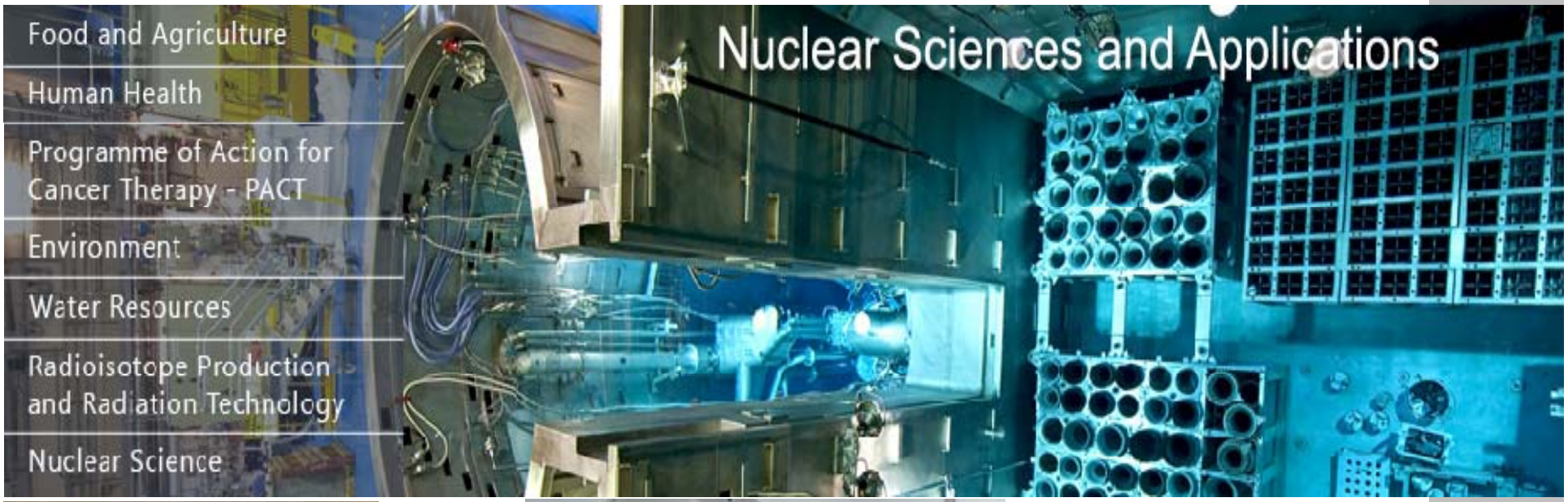


The elements on non-proliferation:

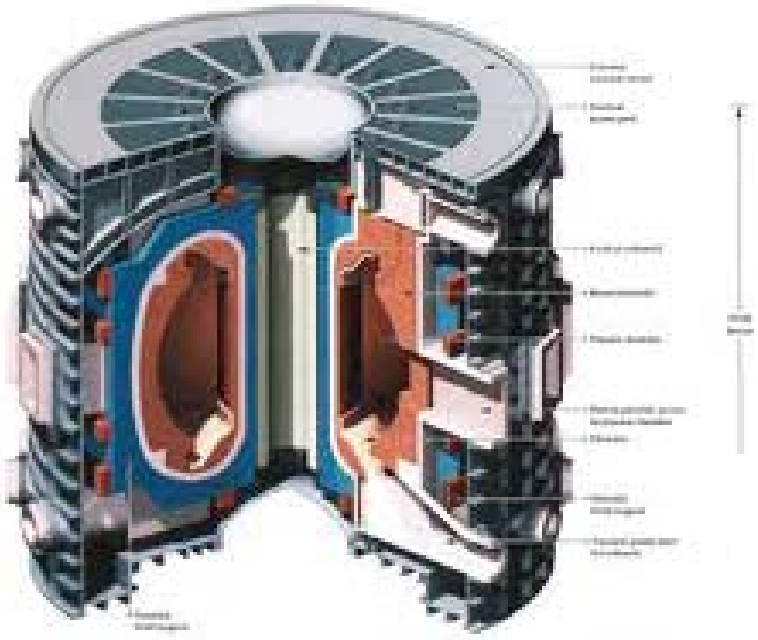
- material control and accounting,
- Physical Security,
- IAEA inspections,
- Technology Export Controls

- Comprehensive test ban

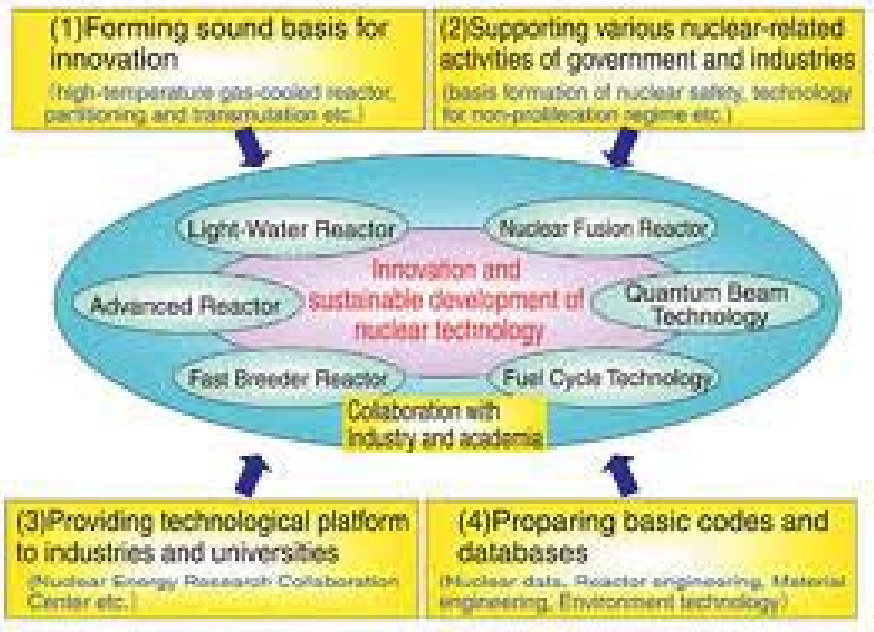
Nuclear Application

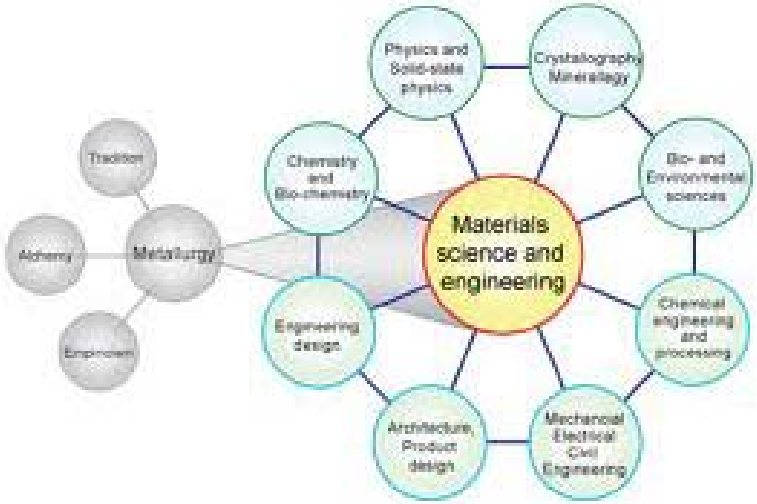


Nuclear Science



A computer-generated model of the International Thermonuclear Experimental Reactor device.





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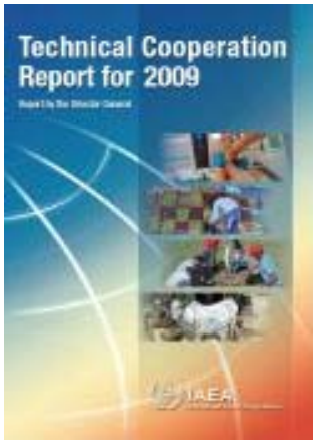
International aspects and organizations



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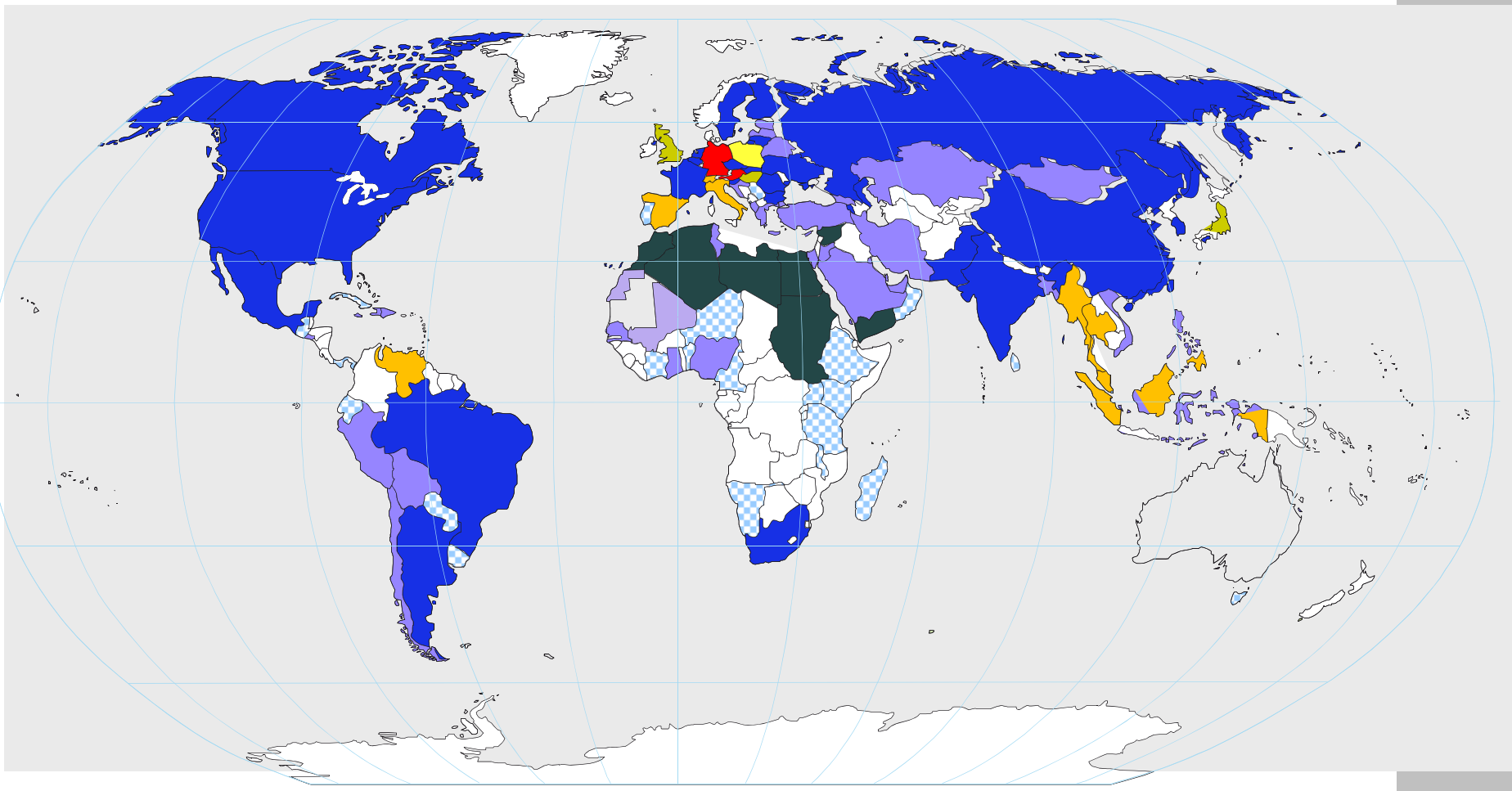
WANO

WNA

Nuclear power landscape, May 2011



Operating | Considering | Expressing interest | Negative | Delaying


Thank You !


ACCESS TO NUCLEAR POWER
Beneficial, Sustainable, Responsible